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EVALUATION OF C-130/C-141 PROTOTYPE GATE RELEASE DEVICE SYSTEM

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AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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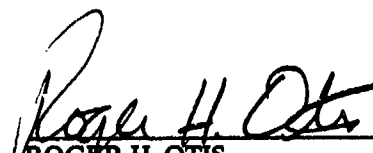
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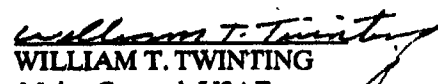

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report presents the results of the C-130/C-141 Gate Release Device (GRD) project. This test program was conducted at Edwards Air Force Base, California between 18 August and 17 September 1987 to evaluate Container Delivery System (CDS) airdrop of equipment from C-130 and C-141 aircraft with a GRD. The GRD was an electromagnetic device designed to replace the knife and pulley system presently used to release A-22 containers. Six tests were conducted from a C-130 and five from a C-141. The C-130 flew at 130 KIAS and the C-141 flew at 150 KIAS. The C-130 flew at altitudes ranging from 600 to 2,000 feet above ground level (AGL) and the C-141 at 1,000 feet AGL at test initiation. Container gross weights ranged from 575 to 2,325 pounds.					
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PREFACE

This project was requested by Test and Commercial Programs, Deputy for Airlift and Trainer Systems, Aeronautical Systems Division, Wright-Patterson AFB, Ohio. The project was authorized by AFFTC Project Directive Number 87-55. The AFFTC Job Order Number was 2377DO. All tests were conducted by the Deceleration Systems Branch, 6520 Test Group, AFFTC Edwards AFB, CA. Testing began 18 August 1987 and was completed 17 September

1987. The authors would like to acknowledge the excellent support provided by the C-130 project loadmasters MSgt Scott Taylor and TSgt Henry F. Hoffmann, range recovery personnel from Computer Science Corporation, personnel from 6515 FMS/MAFMFE, personnel from the 6515 TSS/MATMP, and the flight crews and crew chiefs from the Military Airlift Command (MAC). This technical report constitutes closing action on this project.

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EXECUTIVE SUMMARY

This report presents the results of the C-130/C-141 Gate Release Device (GRD) project. Testing was conducted at Edwards Air Force Base between 18 August and 17 September 1987. Eleven airdrop tests were conducted (six from a C-130E and five from a C-141B aircraft) in a total of six flights. The C-130 and C-141 aircraft were in standard Container Delivery System (CDS) configuration. Both aircraft were fitted with a Center Vertical Restraint (CVR) system. The GRD was an electromagnetic device designed to replace the knife and pulley system presently used to release A-22 containers for CDS airdrops.

The objectives of the project were to: evaluate functional characteristics of the GRD and compatibility with the C-130 and C-141B aircraft; develop aircraft CDS airdrop rigging and in-flight procedures compatible with the GRD; and compile and analyze time increments between release activation, load first movement, and load exit from aircraft. All objectives were accomplished.

In general, the GRD system showed potential for operational use as it functioned satisfactorily and was compatible with the C-130 and C-141 aircraft. Gate Configuration I (Type XXVI nylon webbing with 4-inch loop and attached to a GRD on the inboard side of the skidboard and one Van Zelm ratchet device on the outboard side) had more advantages than both Configurations II (Type XXVI nylon webbing attached to one GRD on the inboard side and two Van Zelm ratchet devices on the outboard side) and III (Type XXVI nylon webbing attached to a GRD which was attached to a chain on the inboard side of the skidboard and

two Van Zelm ratchet devices on the outboard side). The GRD system gave the loadmaster the ability to release a maximum weight load from the C-141 without removing any aft restraints. The average time elapsed from green light to load first movement was reduced 36 percent for the C-130 and 60 percent for the C-141 between the conventional cutting knife system and the GRD. The GRD system using the gate with the 4-inch loop should be considered for operational use.

Three major deficiencies that would affect safety of flight were identified. There was no indication on the control box that the devices were energized. The GRD's power source location limited the loadmaster to the forward end of the cargo compartment. The control box switch arrangement did not allow the loadmaster to dearm the system immediately during an emergency situation. In an operational GRD system these deficiencies should be corrected.

Several other deficiencies were identified which could have a mission impact. The most significant were: the GRD could be activated by accidental tripping of the cocking lever wire loop; the GRDs released inadvertently during ground tests due to insufficient extension stroke. In an operational GRD system these deficiencies should be corrected.

Airdrop rigging and flight procedures were developed and verified. In an operational system, the procedures contained in Appendices A and B should be addressed.

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INTRODUCTION

GENERAL

This report presents the results of the C-130/C-141 Gate Release Device (GRD) project. Douglas Aircraft Corporation (DAC) of Long Beach, CA designed and fabricated a GRD for the C-17 aircraft to be used on Container Delivery System (CDS) airdrops. The Air Force Flight Test Center (AFFTC) performed Development Test and Evaluation (DT&E) of the gate release for compatibility with the C-130 and C-141 aircraft. Eleven airdrop tests were conducted (six from a C-130 and five from a C-141 aircraft) in a total of six flights. Testing at the AFFTC was conducted during 18 August and 17 September 1987. This was accomplished for Aeronautical Systems Division (ASD), Directorate of Test and Commercial Programs, Deputy for Airlift and Trainer Systems (AFTS).

BACKGROUND

This project was in support of a continuing development effort to improve CDS aerial delivery. The first step toward an enhanced C-130 and C-141 CDS capability was the incorporation of Center Vertical Restraint (CVR) rails (see Reference 3). The Type I (C-130) and Type II (C-141) CVR systems were designed to provide lateral and vertical restraint to A-22 skidboards during CDS airdrop operations to minimize the potential for the containers to shift.

The second step was the incorporation of the GRD. CDS containers are presently released using a guillotine knife hooked to the retrieval winch cable of the aircraft. At the release point the loadmaster activates the winch to cut the aft restraint gate. The GRD system was designed to improve Computed Air Release Point (CARP) accuracy by providing a more consistent time from green light to load first movement.

TEST ITEM DESCRIPTION

The C-130E (S/N 637835) and C-141B (S/N 67958) aircraft represented the C-130 and C-141 fleet. They were in standard CDS configuration and were fitted with a CVR system.

The gate release was a prototype electromagnetic device (see Figure 1) which was

attached to the CVR rail rings at various locations in the aircraft cargo compartment (see Figure 2). The device (or mechanism) was activated by a 28-volt DC impulse from aircraft power routed through a control box (see Figure 3) located at the loadmaster's primary position. The GRD was designed to be activated at the CARP. Device activation released one end of a webbing gate, negated aft restraint, and allowed the CDS containers to exit the aircraft through a gravity airdrop while the aircraft maintained a positive deck angle. The number of devices and gates varied depending on aircraft loading and number of containers to be dropped.

The GRD consisted primarily of a linear actuator, a cocking lever, a hook, support and rocker arms, a spool, and a power cable (see Figure 1). The power system wiring, designed by 4950 Test Wing, Wright-Patterson AFB, consisted of a 60-foot long main wiring harness with six connectors, eight 26-inch long extension cables, and a control box (see Figure 4). In addition a 25-foot extension harness with two connectors for the C-141 was provided. The control box had a 25-foot long power cable which was plugged in to a 28-volt DC iron lung outlet, and a 25-foot long retractable cable with the activation switch at the end. The control box also contained a release selector switch (right, left, or both sides) and an arm/dearm switch. The control box was located forward of the buffer stop assembly. The wiring harness was routed on top of the CVR rail and secured with tape. The 26-inch long extension cables were used to power the GRDs at locations away from the main harness connector locations.

Normal activation of the device was accomplished through the activation switch. Upon activation, the linear actuator tongue was retracted allowing the rocker arm near the tongue to swivel inward, freeing the spool and releasing the webbing gate. Retraction of the actuator tongue during rigging was accomplished by use of the cocking lever wire loop. A rubber boot was placed around the device to provide protection from shock loads. A 1 1/4-inch diameter inspection hole was located on one side of the rubber boot.

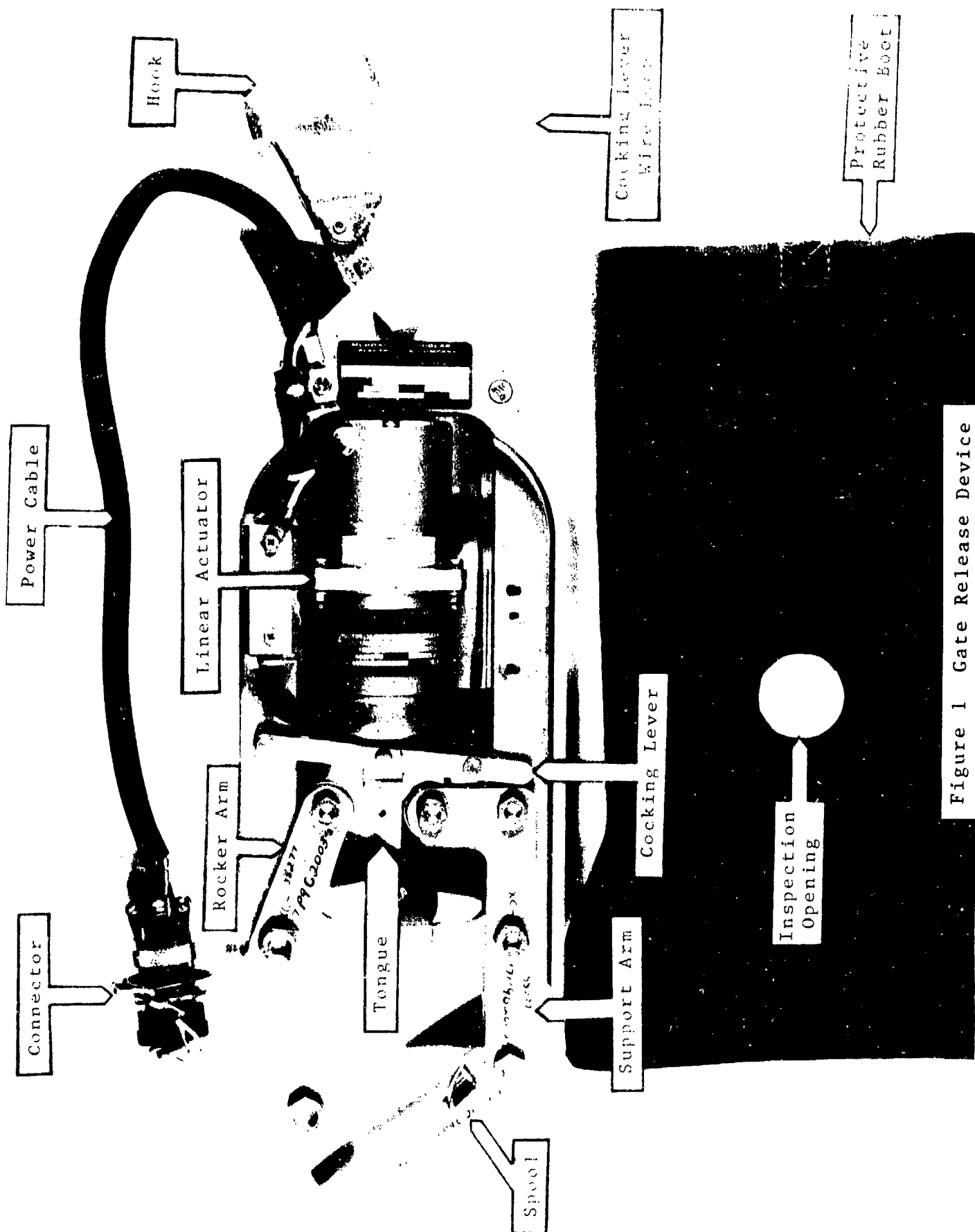


Figure 1 Gate Release Device

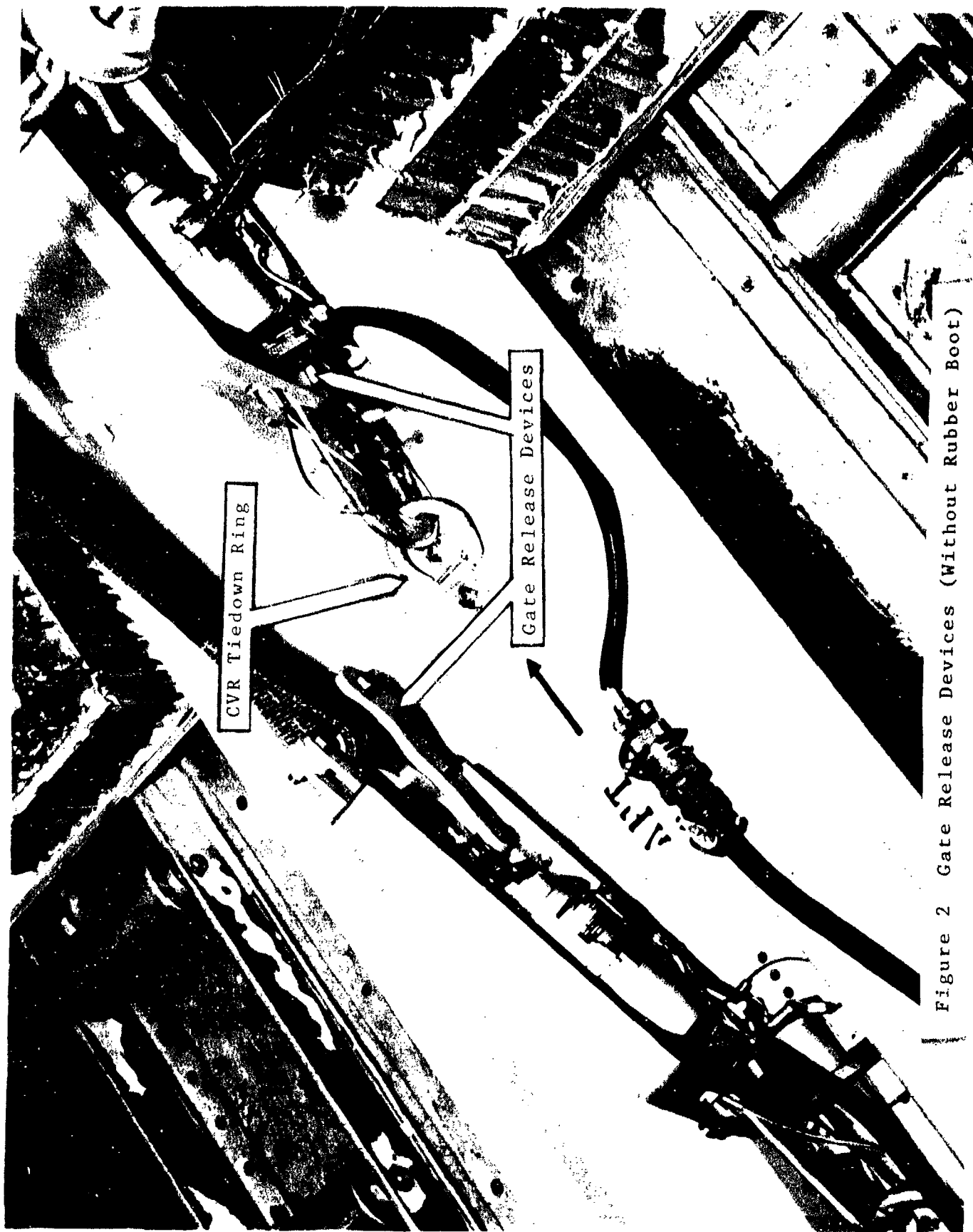


Figure 2 Gate Release Devices (Without Rubber Boot)



Figure 3 Control Box and Switches

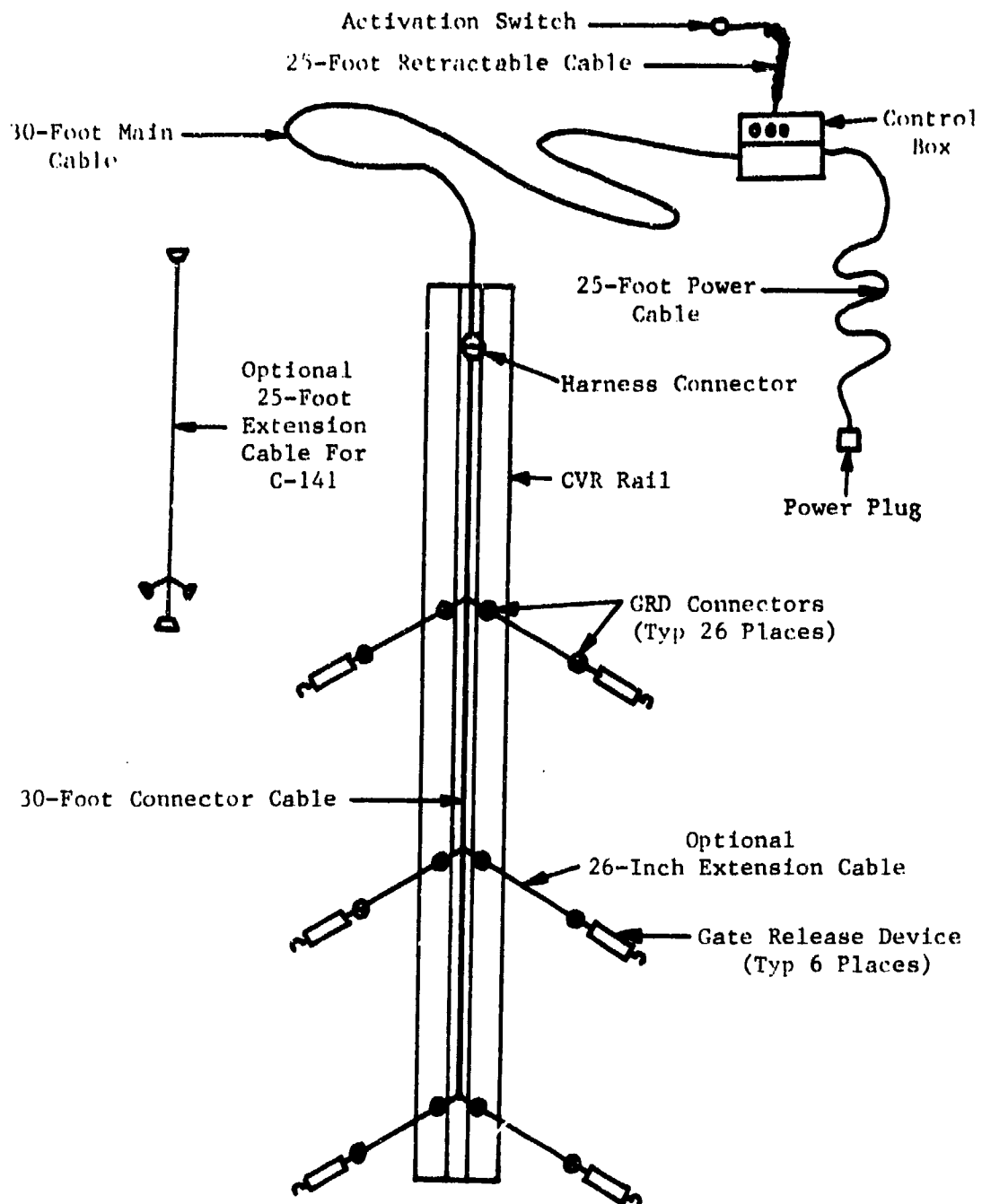


Figure 4 Gate Release Electrical System

TEST OBJECTIVES

The objectives of this test program were to:

1. Evaluate functional characteristics of the GRD system and its compatibility with the C-130 and C-141 aircraft.
2. Develop aircraft CDS airdrop rigging and in-flight procedures compatible with the GRD.
3. Compile and analyze time increments between release activation, load first movement, and load exit from aircraft.

TEST AND EVALUATION

TEST CONDITIONS AND PROCEDURES

Prior to airdrop from both C-130 and C-141 aircraft a system ground check was conducted to ensure proper interface between the aircraft power supply, the control box and the releases. Airdrop tests with each aircraft were accomplished in a build-up manner up to the maximum weight allowed per gate (13,000 pounds as per References 4 and 5).

A photocell sensor system was used to acquire exit time data. Release activation and load first movement data were acquired using a string potentiometer system.

Three different gate configurations were used. These configurations are described in detail in the Rigging Procedures Development section of this test report. Rigged weights of A-22 containers varied from 575 to 2,325 pounds. Two high silhouette and high center of gravity (cg) containers were used on the C-130 (see Figure 5) to determine if a higher gate fall distance affected the Gate Release Device (GRD) operation. Four containers on the C-141 were rigged with ammunition boxes (filled with dead weight) to investigate the possibility of the webbing gate loop area becoming entangled between the boxes (see Figure 6). Two of these containers were rigged with metal ammunition boxes; one was covered with canvas, the other was metal banded. The other two of these containers were rigged with wooden ammunition boxes. Again, one was covered with canvas and one was metal banded.

Deck angles at test initiation were six to nine degrees for the C-130 aircraft and five degrees for the C-141 aircraft. Nominal airdrop speeds were 130 knots indicated airspeed (KIAS) for the C-130 aircraft and 150 KIAS for the C-141 aircraft. The altitude at test initiation was from 600 to 2,000 feet above ground level (AGL). The aircraft cg was within published Technical Order (T.O.) limits.

Due to incorporation of the GRD system, some standard Military Airlift Command (MAC)

Container Delivery System (CDS) airdrop rigging procedures required modification. Changes were made as required by Air Force Flight Test Center (AFFTC) to facilitate testing. Summaries of airdrop test conditions are presented in Tables 1 and 2.

TEST RESULTS

Functional Characteristics And Compatibility:

The test objectives of this project were met. In general, the GRD system showed potential for operational use as it functioned satisfactorily and was compatible with the C-130 and C-141 aircraft. However, several deficiencies were identified which could have a mission impact. Aircraft controllability for both aircraft was satisfactory for the conditions tested. The GRD system using the gate with the 4-inch loop should be considered for operational use. (R1)¹

There was no indication on the control box that the devices were energized. A potentially dangerous situation may occur if a forward GRD failed to release. In that case, part of the load would remain at the forward end of the cargo compartment. If the weight of this remaining load was sufficient it could cause the aircraft to exceed its forward cg limits. An indication that each device is energized must be placed in the GRD system circuit to ensure proper electrical connection.

The GRD's power source outlet (28 volt DC large iron lung style receptacles, PN MS3100R24-9S) location limited the loadmaster to the forward end of the cargo compartment. On a typical MAC CDS training mission, cargo (e.g. trucks, pallets, etc.) is carried throughout the cargo compartment with two to four CDS containers located aft of the cargo. The loadmaster, being up front because of the 25-foot long power cable, may not be able to see the CDS load. A number of smaller 28-volt DC (Atlas lamp style, PN 7526) and

¹ Numerals preceded by an R within parenthesis at the end of a paragraph correspond to the recommendation numbers tabulated in the Conclusions and Recommendations section of this report.

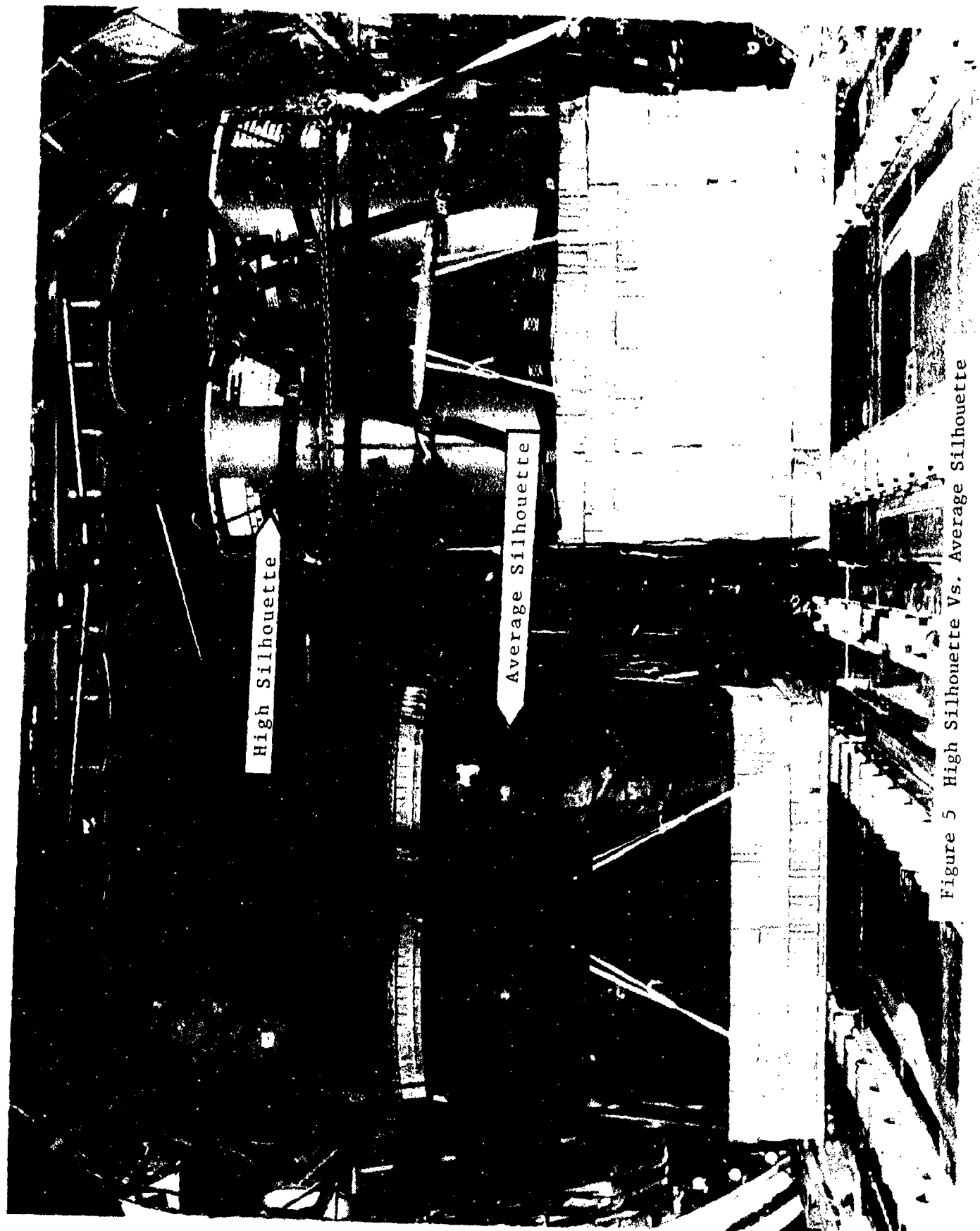


Figure 5 High Silhouette Vs. Average Silhouette



Photo - Wooden Ammunition Boxes (Metal Banded)
Stored in an A-22 Container

TABLE 1
C-130 TEST CONDITIONS¹

Test No.	A-22s No.	Load Gross Weight (lb)	Device Position (FS)	Gate Position (FS)	Airdrop Configuration
1-1	1	575	710L ²	730L	SINGLE-STICK
1-2	2	1175	655L	680L	SINGLE STICK
1-3	5	8125	545L	580L	SINGLE-STICK
1-4	8	13000	710R ³	730R	SINGLE-STICK
2-1	12	27900	490L 720L 510R 700R	537L 730L 537R 730R	DOUBLE-STICK
3-1	16	37200	443L 720L 477R 700R	490L 730L 490R 730R	DOUBLE-STICK

¹ Deck angles were from 6 to 9 degrees and altitudes ranged from 600 to 2000 feet AGL. Target airspeed was 130 KIAS.

² Left.

³ Right.

TABLE 2

C-141B TEST CONDITIONS¹

Test No.	A-22s No.	Load Gross Weight (lb)	Device Position (FS)	Gate Position (FS)	Airdrop Configuration
1-1	1	600	1318R ²	1355R	SINGLE-STICK
1-2	2	1150	1257R	1300R	SINGLE STICK
1-3	7	13000	1157R	1210R	SINGLE-STICK
2-1	18	38995	757L ³ 1032L 1321L	804L 1096L 1382L	SINGLE-STICK
3-1	28	60485	825L 1000L 1224L 777R 1005R 1260R	874L 1066L 1306L 825R 1066R 1309R	DOUBLE-STICK

¹ Deck angle was five degrees and altitude was 1000 feet AGL. Target airspeed was 150 KIAS.

² Right.

³ Left

115-volt AC (PN MS3100R18-10S) receptacles were located throughout the cargo compartment of both aircraft. A power analysis must be conducted to determine if one of those receptacles can be used to activate the GRDs and if so, the power cable plug must be made compatible with those receptacles to allow more rigging flexibility and increased safety. In the case of 115-volt AC receptacles, the linear actuator must also be made compatible with AC.

During a "no drop" or emergency situation the primary loadmaster must be able to immediately dearm the system without having to move back to the control box. The arming switch must be placed on the same hand-held unit as the activation switch to allow the loadmaster to dearm the system immediately during an emergency.

In an operational GRD system the above deficiencies affecting safety of flight should be corrected. (R2)

The spools were modified because the Type XXVI, MIL-W-4088 nylon gate loop got caught on the corner of them (see Figure 7) during ground tests. This modification consisted of machining the attachment point side of the spool to a 30-degree angle (see Figure 8) and no problems were encountered. The GRD spools must be modified to prevent snagging.

During ground tests a loadmaster accidentally activated the release device by stepping on the cocking lever wire loop. The incident was easily duplicated. During flight test these wire loops were placed inside the rubber boots to minimize the possibility of accidental activation of the device and no other incidents were encountered. The cocking lever wire loop must be repositioned or redesigned to preclude accidental activation of the device.

Two of the GRDs (S/N 003 and 006) released inadvertently during ground checks. Inadvertent release was due to insufficient extension stroke (1/4 inch rather than the designed 1/2 inch) of the linear actuator cylinder (see Figure 9). One of the GRD's extension stroke self-corrected after being subjected to a tension force of 50 pounds. The other device actuator had a 1/4-inch extension stroke even after being subjected to two releases at 1,700 and 1,800 pounds. Both GRDs were sent to Douglas Aircraft Company (DAC) for inspection and repair. During C-141 testing four more incidents occurred but, after one of DAC's engineers manipulated the cocking lever, the

extension strokes returned to the designed 1/2 inch. The linear actuator extension stroke must be repeatable with easy verification. Possible solutions to the verification problem are the incorporation of alignment marks and/or the reposition of the inspection opening to show the cocking lever.

The round opening at the side of the rubber boot (see Figure 1) was inadequate for inspection of the extension stroke on the linear actuator. Consideration must be given to the number and size of the opening in order to facilitate inspection.

The electrical power wires (see Figure 10) could suffer severe damage if mishandled. The steel cables were adequate protection against tension force but are not adequate for compression or bending forces. Complete protection to the electrical wires must be provided.

The main power cable and the 25-foot extension cable had eight 26-inch extension cords and a total of eight connectors (four sets of two) spaced more than 11-feet apart. This arrangement does not allow enough flexibility of gate rigging locations. Had a mission required 40 containers, with three gates per side restraining seven, seven and six containers respectively, the prototype system would not work longitudinally because the extension cords were not long enough to reach the connectors at the end of the cable. For the C-141 the minimum distance between outside connectors (i.e. end-to-end) must be 60 feet. Production main power cable and extension cable must have electrical connectors installed at shorter intervals (i.e. 6 feet) to improve operational utility. Additionally, on the prototype system the distance between the control box and the first set of connectors was approximately 39 feet on the C-130 and 52 feet on the C-141. These distances were excessive and must be shortened to 20 feet.

In an operational GRD system the above deficiencies should be corrected. (R3)

Rigging Procedures Development:

Standard MAC CDS airdrop rigging procedures were modified for use with the GRD system. Appendices A and B describe in detail the rigging procedures and Appendices C and D contain the checklists developed by the AFFTC for this project. In an operational system, the



Figure 7 Gate Caught on Corner of Spool



Figure 8 Modified and Unmodified Spools

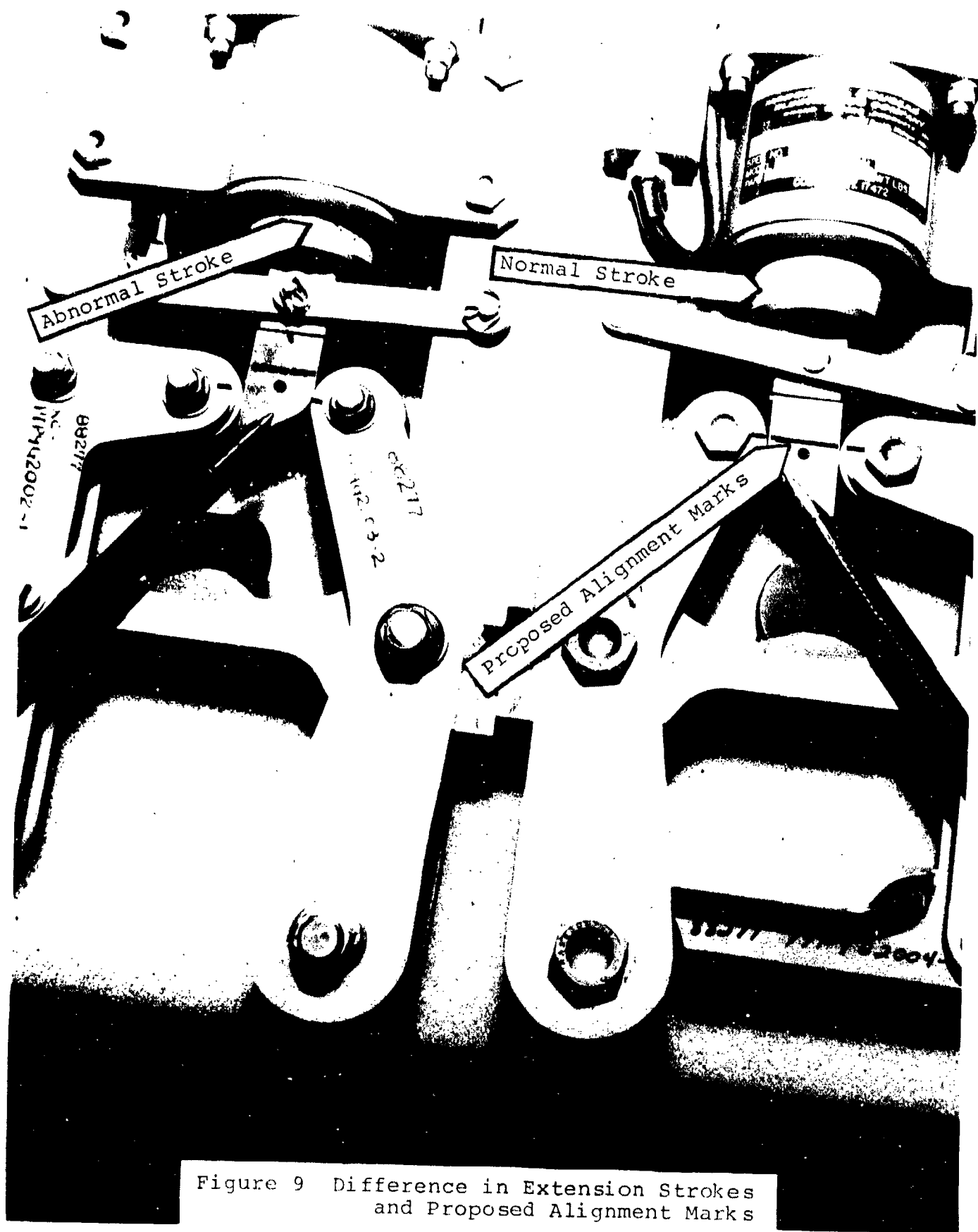


Figure 9 Difference in Extension Strokes
and Proposed Alignment Marks



Figure 10 Unprotected Electrical Wires

procedures contained in Appendices A and B should be addressed. (R4)

An additional benefit gained with the GRD system was the ability to release a maximum weight load from the C-141 without removing any aft restraints. On operational drops the loadmaster is required to remove the additional restraint before the drop, however, with the GRD system the devices provided all the restraint (including takeoff) required. This will save in-flight preparation time during operational CDS airdrops. The interface between the GRDs and both the C-130 and C-141 Center Vertical Restraint (CVR) rail was satisfactory. The devices and controls operated in an acceptable manner on all test flights.

Three different gate configurations were tested. The initial test configuration, Configuration I, consisted of a GRD, a MIL-W-4088 Type XXVI nylon gate with a pre-sewn 4-inch long loop in one end and a Van Zelm ratchet device (see Figure 11). The loop end of the gate was attached to a CVR tiedown ring using the gate release device. The other end was threaded through the container aft corner at or near vertical cg and above the horizontal band (see Figure 12) and attached to a floor tiedown ring on the outboard side of the container using a Van Zelm device.

During testing two other configurations were developed. Configuration II consisted of a GRD, a single piece of Type XXVI webbing (see Figure 13), and two Van Zelm devices. One end of the webbing gate was attached to the outboard side with a Van Zelm device. The other end was fed through the GRD located on the CVR rail and back to another Van Zelm device on the outboard side.

Configuration III was similar to Configuration II but rather than attaching the GRD's hook directly to a single tiedown ring on the CVR rail, the hook was attached to a 10,000-pound capacity

chain which was attached to two tiedown rings on the CVR rail (see Figure 14). This configuration did not affect the maximum weight allowed per gate because the weakest point still is the 10,000-pound rated GRD. Aeronautical Systems Division (ASD) requested this configuration be tested for compatibility. Their ultimate goal, although not tested, was to determine if the 1.5 times the normal acceleration due to gravity (G) aft load restraint requirement during takeoff and landing could be achieved through the use of a single GRD.

All three configurations functioned as expected and the nylon gates passed through the A-22 netting without problems. Configuration I was simpler to rig than the other two configurations. Also, this configuration required the fewest number of Van Zelm devices per gate. Configuration II did not need a pre-sewn loop in one end of the webbing gate. This can be an advantage operationally. Configuration III had no advantages over Configurations I and II. This could change if GRDs were to be rated at a higher load limit. Both Configurations II and III doubled the number of Van Zelm devices required per gate over that required by Configuration I. As explained above, Configuration I had more advantages than both Configurations II and III. Configuration II can be used as an alternate method of aft restraint. Configuration I should be considered for operational use. (R1)

Time Increments:

Specific test results are presented in Tables 3 and 4. The average time elapsed from green light to load first movement was reduced 36 percent for the C-130 and 60 percent for the C-141 between the conventional cutting knife system and the GRD. (Data on the conventional system was obtained from Reference 3.) Since the number of tests was limited, these results are not statistically significant. Times from load first movement to exit time were not affected. The difference in exit times between the right and left sides of the aircraft was due to the difference in weights of the A-22 containers.

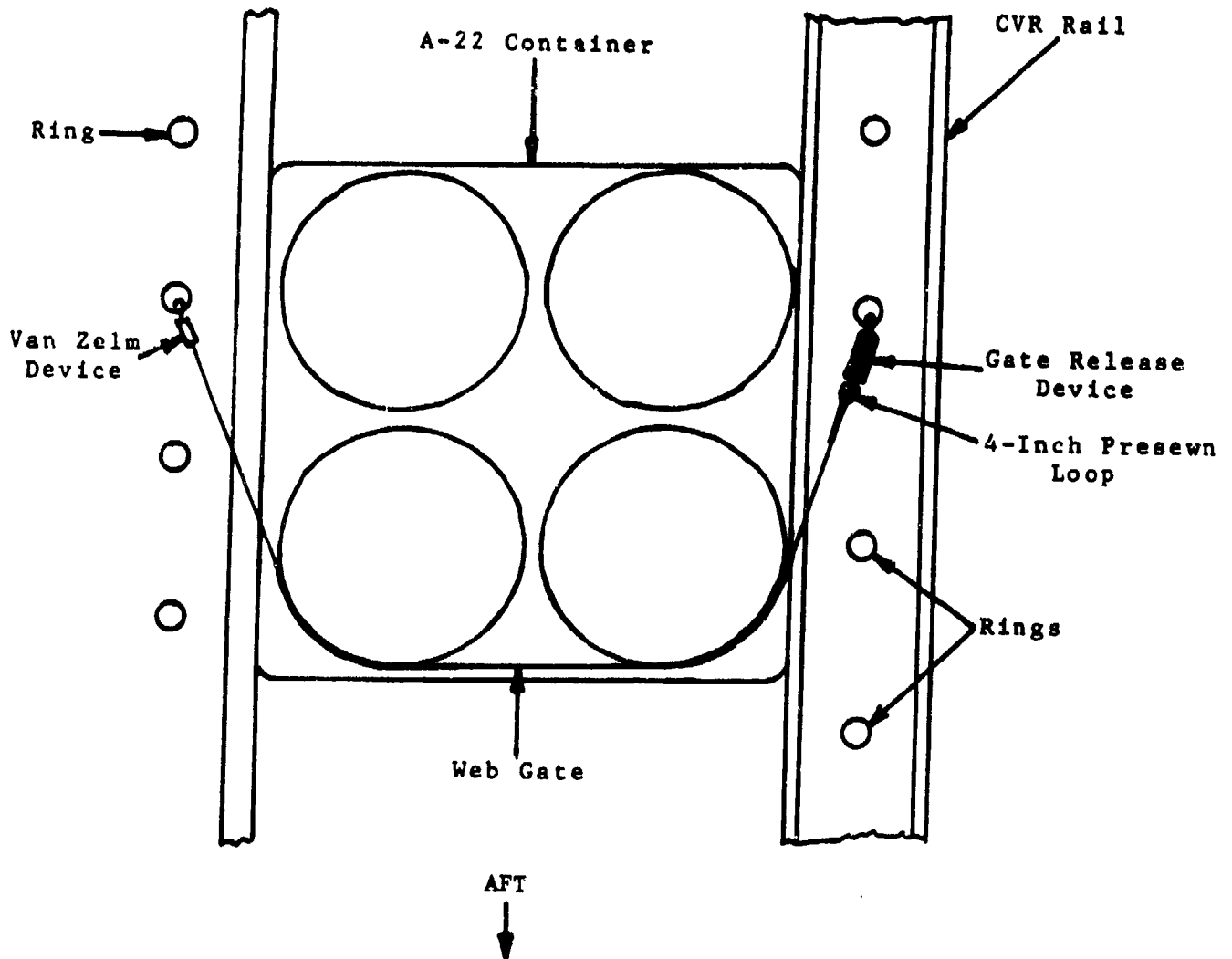


Figure 11 Gate Configuration I

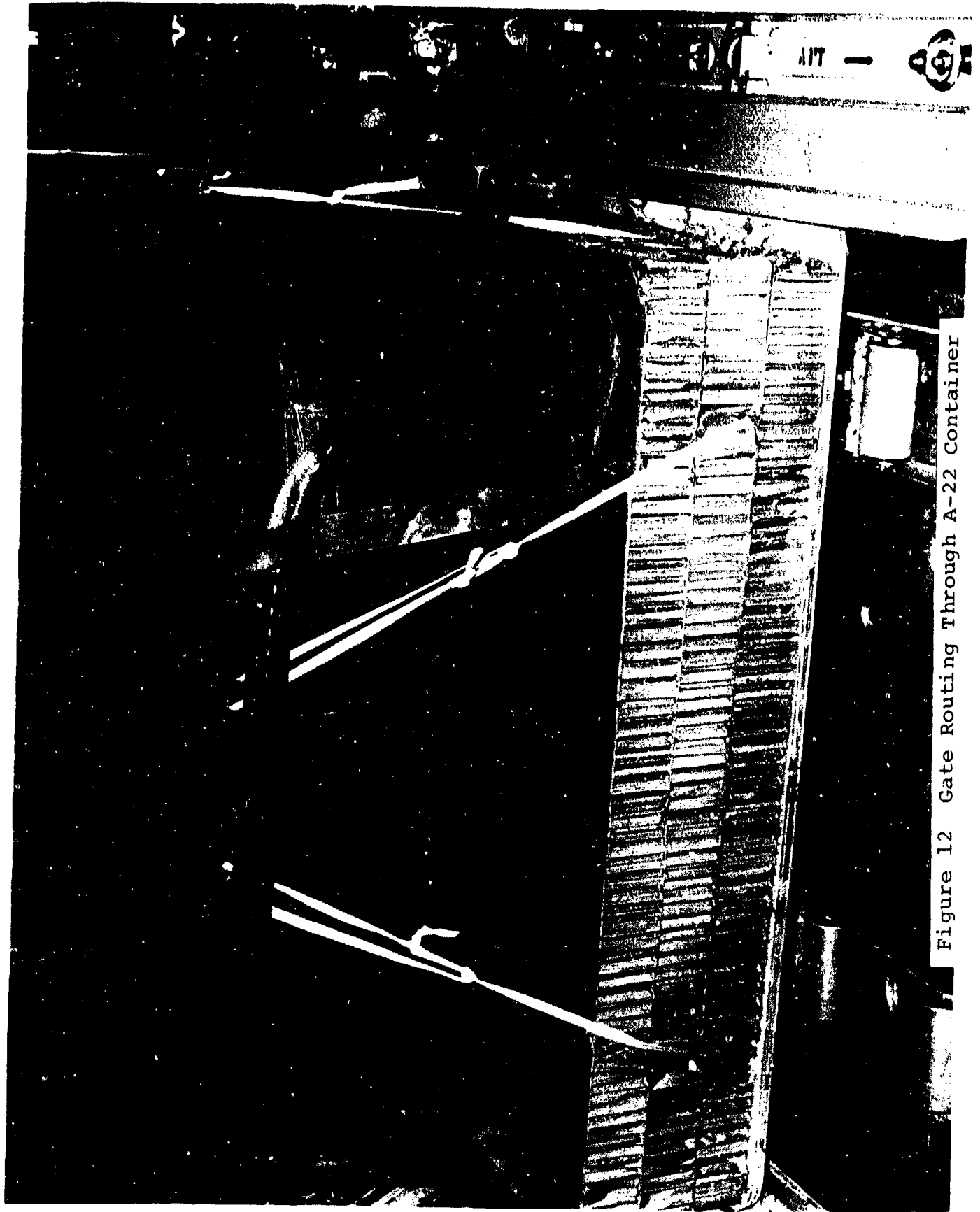


Figure 12 Gate Routing Through A-22 Container

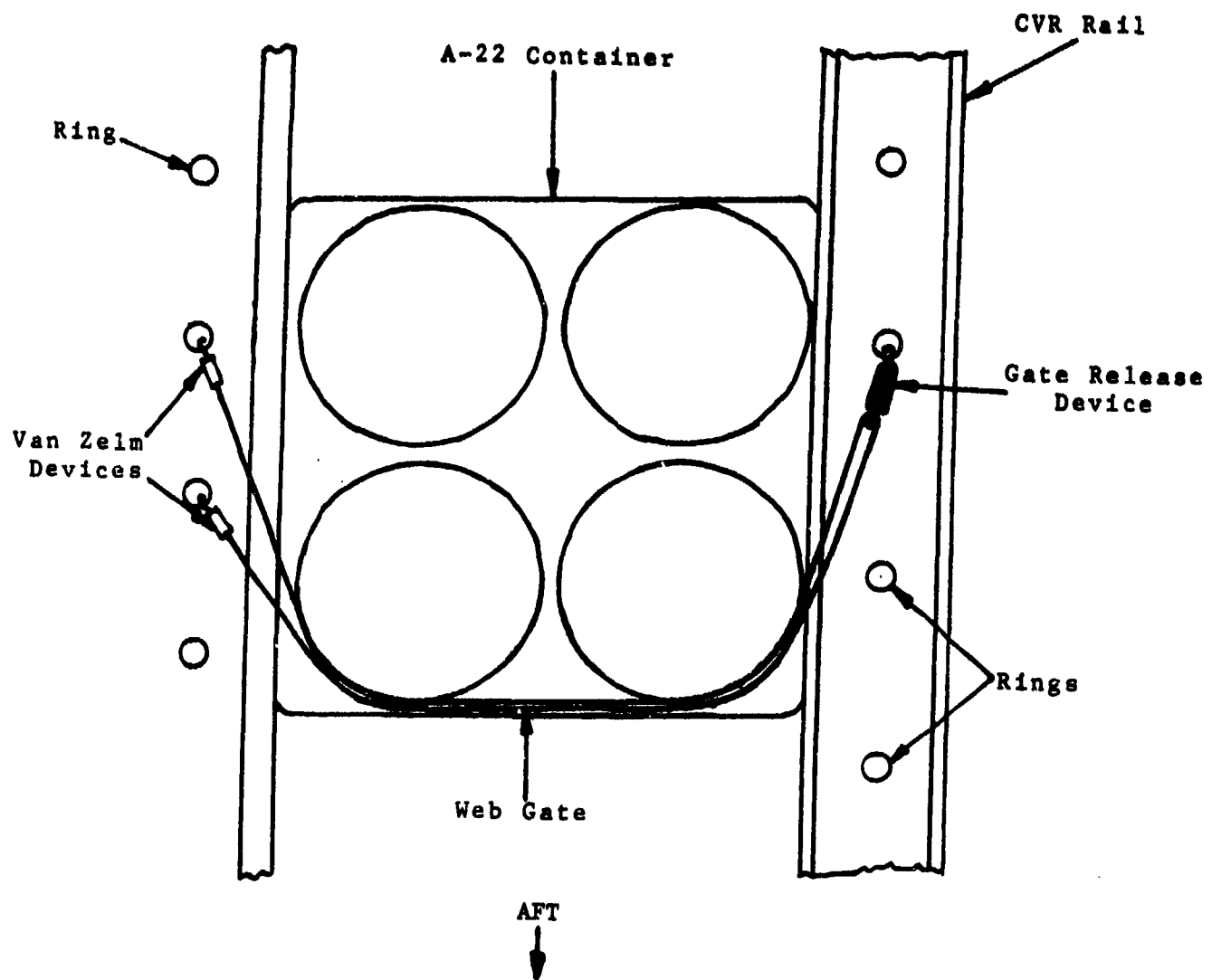


Figure 13 Gate Configuration II

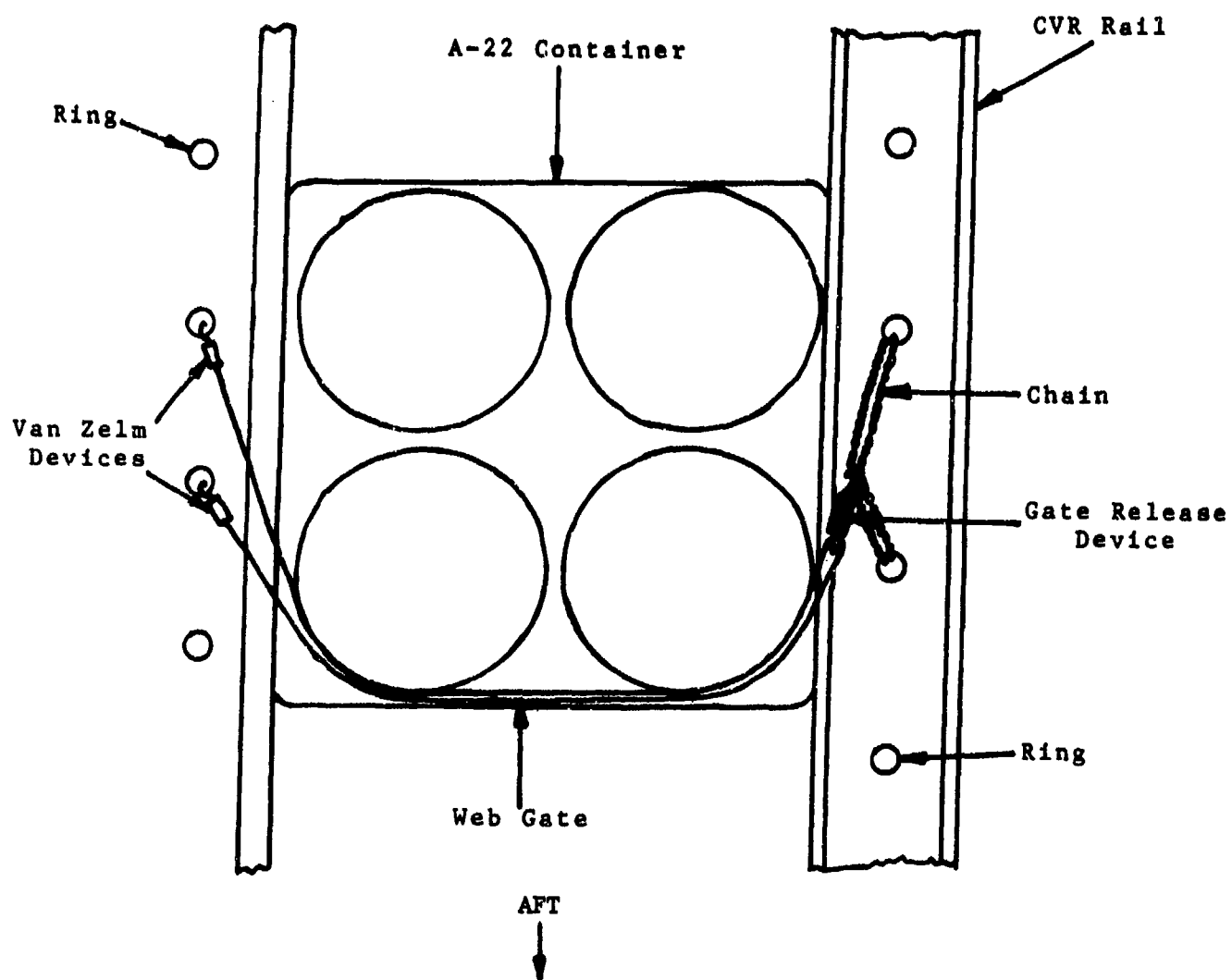


Figure 14 Gate Configuration III

TABLE 3
C-130 TEST RESULTS

Test No.	Indicated Airspeed (KIAS)	Flap Setting (%)	Max Deck Angle (deg)	Time			
				Green Light To Load First Movement		Load First Movement To Exit	
				Side		Side	
				Left (sec)	Right (sec)	Left (sec)	Right (sec)
1-1	131	23	9	0.1	---	2.8	---
1-2	134	21	8	1.0	---	3.1	---
1-3	135	19	7	NA ¹	---	NA	---
1-4	130	27	7	NA	NA	NA	NA
2-1 ²	132	33	7	NA	0.6	NA	NA
3-1 ³	130	37	6	0.8	0.6	4.6	5.1

¹ Not available

² Gate Configuration II was used on one of the gates.

³ Gate Configuration III was used on one of the gates.

TABLE 4
C-141B TEST RESULTS ¹

Test No.	Indicated Airspeed (KIAS)	Flap Setting (%)	Max Deck Angle (deg)	Time			
				Green Light To Load First Movement		Load First Movement To Exit	
				Side		Side	
				Left (sec)	Right (sec)	Left (sec)	Right (sec)
1-1	150	40	5	---	0.5	---	3.5
1-2	150	40	5	---	0.5	---	NA ²
1-3	150	40	5	---	1.6	---	NA
2-1	150	44	5	0.2	---	7.6	---
3-1	150	40	5	1.1	1.0	5.9	6.5

¹ Gate Configuration I was used on all tests.

² Not available.

CONCLUSIONS AND RECOMMENDATIONS

The test objectives of this project were met. In general, the Gate Release Device (GRD) system showed potential for operational use as it functioned satisfactorily and was compatible with the C-130 and C-141 aircraft. Gate Configuration I had more advantages than both Configurations II and III. Configuration II can be used as an alternate method of aft restraint. The GRD system gave the loadmaster the ability to release a maximum weight load from the C-141 without removing any aft restraints. The average time elapsed from green light to load first movement was reduced 36 percent for the C-130 and 60 percent for the C-141 between the conventional cutting knife system and the GRD. However, several deficiencies were identified which could have a mission impact.

1. The GRD system using the gate with the 4-inch loop should be considered for operational use. (Page 15 and 25)

Three major deficiencies that would affect safety of flight were identified:

- There was no indication on the control box that the devices were energized.
- The GRD's power source location limited the loadmaster to the forward end of the cargo compartment.
- The control box switch arrangement did not allow the loadmaster to dearm the system immediately during an emergency situation.

2. In an operational GRD system the above deficiencies affecting safety of flight should be corrected. (Page 20)

The following list contains other deficiencies identified which could have a mission impact:

- The Type XXVI, MIL-W-4088 nylon gate loop could catch on the GRD spools.
- The GRD could be activated by accidental tripping of the cocking lever wire loop.
- The GRDs released inadvertently during ground tests due to insufficient extension stroke.
- Inspection of the extension stroke was difficult because of lack of alignment marks and of the number, size, and location of the rubber boot inspection opening.
- The electrical power wires were not satisfactorily protected against compression and bending forces.
- The number of connectors and their spacing did not allow sufficient flexibility of gate rigging locations.

3. In an operational GRD system the above deficiencies should be corrected. (Page 25)

Airdrop rigging and flight procedures were developed and verified.

4. In an operational system, the procedures contained in Appendices A and B should be addressed. (Page 25)

REFERENCES

1. MACR 55-47 C-130 Configuration/Mission Planning, 31 Dec 80.
2. MACR 55-4 C-141 Configuration/Mission Planning, 1 Oct 79.
3. Lopez, Miguel A. and Wuest, Michael R., C-130/C-141 Center Vertical Restraint, AFFTC-TR-86-5, Air Force Flight Test Center, Edwards AFB, California, July 1986.
4. TO-1C-130A-9 C-130A Technical Manual Loading Instructions, 16 June 1980, Change 6, 26 April 1985.
5. TO-1C-141-9 C-141 Technical Manual Loading Instructions, 5 November 1984.

APPENDIX A
C-130 TEST RIGGING PROCEDURES

C-130 TEST RIGGING PROCEDURES

RIGGING PROCEDURES FOR THE CONTAINER DELIVERY SYSTEM (CDS) USING THE C-130 CENTERLINE VERTICAL RESTRAINT (CVR) AND GATE RELEASE DEVICE (GRD) SYSTEMS

1. This section provides the aircraft rigging procedures for CDS airdrop from the C-130 aircraft when using the CVR and GRD systems. CDS rigging procedures IAW T.O. 1C-130A-9, were followed to the fullest extent possible, however, because of the greater flexibility provided by the CVR and GRD systems, some changes were made to the current rigging procedures.

2. The CVR and GRD systems permit the airdrop of up to eight A-22 containers from each side of the aircraft. Each container can be rigged and airdropped in a single pass for a total of 16 individual containers, or all eight can be airdropped from either side on a single pass. In addition, any number up to 16 containers can be airdropped simultaneously. Operational requirements will dictate the rigging configuration.

3. CVR System Description:

a. The Type I CVR system is designed for use in the C-130 aircraft and is interchangeable with all C-130 aircraft serial number 56-510 and higher, including all subsequent models. The CVR system uses the existing tiedown rings in the aircraft and provides a similar set of tiedown rings as a replacement. The tiedown rings on the CVR are rated at 10,000-pound capacity. All CVR components are labeled to ensure proper installation.

b. Each system contains the following components:

Section No.	Nomenclature	Section Length	Quantity	Weight
1	Aft ramp assembly	60"	1	37.0 lbs
2	Forward ramp assembly	60"	1	36.0 lbs
3	Aft cargo compartment assembly	54"	1	43.0 lbs
4	Interchangeable main assembly	80"	4	56.0 lbs
5	Interchangeable main assembly	40"	2	28.5 lbs

Rail dimensions are: 3.95 inches high by 13.75 inches wide. Total system weight is 397 pounds. The CVR may extend from FS 288 to FS 860.

c. Tools and Personnel Required: There are no tools required to install the CVR. Two people are required for installation or removal of the CVR.

4. GRD System Description:

a. The gate release is an electromagnetic device which is attached to the CVR rail and is activated by a 28-volt DC impulse from aircraft power routed through a control box located at the primary loadmaster's position. The GRD is designed to be activated at the Computed Air Release Point (CARP) a selected release point. With the aircraft maintaining a positive deck angle, activation releases one end of a webbing gate, negating aft restraint, and allow CDS bundles to exit the aircraft through a gravity airdrop. The number of devices and gates can vary depending on aircraft loading and number of CDS containers. The devices attach at various locations to the CVR rail.

5. Aircraft Preparation - Prepare the aircraft for CDS airdrop as follows:

- a. Secure seats in upright position beside and aft of preplanned load position. Remove and stow wheel well seat support equipment if container(s) is loaded in this area.
- b. Unlock all left and right hand locks. If the center channel is not required, omit step c.
- c. Center channel installed (if required).

NOTE

If the total weight of all containers is 15,000 pounds or less, the center channel is not required provided four dual rail locks are engaged in the Buffer Stop Assembly (BSA).

NOTE

When load weight is 15,000 or more and the center channel is not available (four locks will be engaged), supplemental restraint will be applied directly to the BSA.

- (1). Remove tiedown rings 3 through 9 from D column. Stow rings, metal straps, and bolts.

NOTE

Center channel may be repositioned on D column if required to satisfy preplanned load position.

- (2). Position spacer washers over tiedown ring bolt holes, and center channel over spacer washers with appropriate holes aligned over D-3 tiedown point. Install Phillip head bolts.

d. Installing BSA - The BSA provides 3 Gs forward restraint for 16 A-22 containers rigged to a maximum capacity (2,200 pounds). The BSA will be installed when the total A-22 containers weigh 5,001 pounds or more and are airdropped on a single pass. When airdropping a combined rigged weight of 5,000 pounds or less, a chain gate system may be used in lieu of the BSA.

NOTE

The chain gate system used as an alternate forward barrier is not to be considered as adequate forward restraint for takeoff or landing. Additional forward restraint must be applied IAW tiedown principles/procedures in Section IV of TO 1C-130A-9.

NOTE

On airplanes without sidewall rings aft of the wheel well, a CGU-1/B strap may be used as an alternate barrier. This method will not be used for loads weighing 5001 pounds or more. In all cases a chain gate will be installed for forward restraint. In addition, a forward barrier will be installed at the first point that sidewall rings are available.

NOTE

When the chain gate system is used as an alternate barrier and the aircraft side wall rings are not symmetrical, a CGU-1/B tiedown strap may be used as an additional alternate barrier. Ensure the chain barrier is installed as close as possible to the bundles.

- (1). Load and position the BSA so that the aft edge of the A-22 container(s) will be positioned no further aft than FS 730.

NOTE

If the center channel is not required, install vertical restraint with 10,000-pound capacity chains over the horizontal panel to cargo floor tiedown rings in C and E column.

- (2). Install center channel H block and the three vertical restraint bolts. Sequentially unlock all left-hand locks aft and adjacent to the preplanned load position.

NOTE

Extend the vertical restraint flanges if containers are loaded in this area and leave them extended throughout the drop.

- c. Retract and secure ramp detent locks to floor tiedown rings 27A and G with Type III nylon cord.

- f. Installing CVR Rail -

NOTE

Ensure all D-Row tiedown rings required for installation of the CVR are positioned to face either forward or aft.

NOTE

BSA must be positioned on the aircraft prior to installation of CVR.

- (1). Ramp Floor Section - The ramp section consists of one aft ramp assembly and one forward ramp assembly.

- (a). The ramp sections must be installed using the D-Row tiedown rings. Beginning with Section 1, position the cutouts in the CVR over D-Row with the tapered end facing aft. Stand the tiedown rings up and place a block into the aft and forward side of each cutout in the rail. To secure the blocks, slide the wedge, flat side down over the pinholes, through the notch in the block, through the aircraft tiedown ring and the notch in the second block until firmly in place. Insert the quick release pin into the hole closest to the wedge kick plate to secure the wedge.

- (b). Install the forward ramp rail, Section 2, using the method explained in (a) above. Ensure the alignment pins of Section 1 overlap Section 2.

(2). Cargo Floor Section - The cargo floor section consists of two 40-inch interchangeable main assemblies, four 80-inch main rail assemblies and one 54-inch aft cargo assembly. Installation will start at the ramp hinge point and work forward.

CAUTION

No more than one aircraft tiedown ring per 80-inch or 54-inch section can be missing for restraint of the CVR to the aircraft floor. No two consecutive aircraft tiedown rings can be missing. No aircraft tiedown rings can be missing from the 60-inch or 40-inch sections.

(3). Installation without the BSA - Position Section 3 at the ramp hinge point onto the cargo compartment floor over D- Row. Stand the tiedown rings up and place a block into the aft and forward side of each cutout in the rail.

NOTE

Forward ramp Section 2 will overlap the aft cargo Section 3.

To secure the blocks, slide wedge through the ring until firmly in place. Insert pin into closest hole to the wedge kick plate to secure. Continue this procedure until all blocks are secure. Install remaining 40/80-inch rails as instructed above until all sections are secure.

(4). Installation with the BSA - Follow the instructions in (3) until the CVR rail overlaps the BSA center guide rail. At this point, use retaining pins and/or tapered wedges to secure the rails.

NOTE

It may be necessary to install the retaining pins into the CVR prior to completely securing the center channel assembly to the aircraft floor.

(5). Install the retaining pins through the holes in the CVR rail into the BSA center guide rail. The retaining pin is keyed to lock into the CVR rail. Rotate the pin so the flat part is facing down and insert the pin into the rail. Insert safety pin into the retaining pin. Follow the above procedure for the remaining holes in the CVR rails that overlap the center channel assembly.

NOTE

The 40-inch main rail assemblies may not be used with the BSA installed.

(6). Removal of the Assembly - Removal of the assembly starts with the cargo compartment and finishes with the ramp section. To remove the cargo compartment assemblies, start with the forward most rail and work aft to the ramp hinge point. For each rail assembly, remove blocks or pins as required.

g. Position anchor cable stops at FS 749 (right side) and 773 (left side).

NOTE

On airplanes with aft body strakes installed, the anchor cable stops must be positioned at FS 821 (right side) and FS 845 (left side).

h. Loading Containers.

CAUTION

Containers with damaged or warped skidboards may result in delayed release or a hung load.

CAUTION

When accomplishing multiple deliveries, the airplane center of gravity (cg) must be precomputed to determine airplane cg after each delivery.

(1). Ensure applicable portions of the DD Form 1748 have been completed. Check containers for the following:

(a). Parachute(s) for proper position. Ensure all G-12Ds are positioned with the bridle and 68-inch pilot parachute on the outboard or forward side of the container.

(b). Skidboard ties taut.

CAUTION

Slack skidboard ties may contact rollers and prevent the container(s) from exiting the airplane.

(2). Load container(s) into the airplane. Forward container(s) will be positioned against the forward BSA or alternate forward barrier.

i. Installing Release Gate (MIL-W-4088 Type XXVI Nylon) -

(1). The CDS release gate will be installed in a one ply configuration (Configuration I) on each stick of containers to satisfy all aft restraint requirements as follows:

(a). 575-13,000 pounds per stick - 1 ply

NOTE

Multiple release gates may be required for each stick depending on weight.

(2). Route and tape with cloth reinforced rigging tape the main wire harness along the top of the CVR where it will not interfere with containers. Connect the main wire harness extension if needed to reach aft gate positions.

(3). Connect release device electrical cable to main wire harness connector. Install an extension cable if required to reach main connector.

(4). Position control unit within 25 feet of one of the two large 28-volt DC outlets and plug in power cord to the outlet.

(5). Perform a system operational checkout.

CAUTION

Duty cycle for the release device is 5 seconds on and 20 seconds off.

(a) Pull and hold the cocking lanyard while swinging the spool free of the rocker arm. Release cocking lanyard. Slip the loop end of a Type XXVI nylon webbing gate over the spool of the release device, pull and hold the cocking lanyard and push the spool in past the rocker arm roller, then release the cocking lanyard to reset device so the rocker arm roller captures the spool/gate. Check for full extension of linear actuator tongue. Forward rocker arm roller must not rest on beveled slope of the tongue or full aft restraint will not be achieved.

(b) Place the arming switch on the control unit to the armed position and verify arming light is on.

(c) Set gate position select switch to position being used for drops.

(d) Apply a positive force against release device by pulling on webbing gate and while maintaining force, activate gate release button. Webbing should slip freely off the spool.

(e) Repeat steps (a) through (d) for each GRD being used.

(f) Dearm electrical power when checkout procedure is complete.

(6). Position container(s) against forward barrier and install the Type XXVI release gate(s) as follows:

(a). Attach the gate release device to a CVR tiedown ring with inspection opening in rubber boot facing out. Attach loop end of the Type XXVI nylon gate to a gate release device and arm the device. For Configurations II and III described in the Test Conditions and Procedures of this report, pass one end of a 25,000 pound capacity chain through two CVR tiedown rings and attach both ends. Attach the gate release device to the two sections of chain formed by the loop (see Figure 14). Pass the Type XXVI nylon webbing through the spool forming a continuous loop.

CAUTION

Ensure the beveled portion of the linear actuator tongue is completely extended past the forward rocker arm roller. The release device will not provide full aft restraint if the rocker arm roller rests on any part of the beveled slope.

(b). Attach a Van Zelm device (or two devices for Configurations II and III) to the outboard right/left tiedown ring. Thread the other end(s) of the Type XXVI nylon through the container aft corner at or near vertical cg of load and above the horizontal band of the container. The Type XXVI nylon should be under vertical bands at aft corners of container and on top of inner vertical bands. Thread end into Van Zelm ratchet(s). Tighten device until a minimum of one and one half turns of webbing is around the spindle to prevent slippage. Fold and secure excess webbing.

NOTE

Configuration I must be used if possible. Use Configuration II as alternate if the 4-inch presewn loop gate is not available.

NOTE

Due to the location of tiedown rings on the CVR, the Van Zelm ratchets and gate release device will not be symmetrical.

(c). Tie a length of MIL-C-5040 Type III nylon cord to the body of the outboard ratchet(s) near the spool and remove slack before securing free end of nylon cord to a tiedown/seat belt ring aft of the ratchets. This tie will prevent the ratchet from jamming the exiting containers. If additional gates/devices are required rig them as per the method cited above.

(7). Emergency Aft Restraint Requirements: CDS. An emergency aft restraint bridle constructed of Type XXVI nylon with a Van Zelm ratchet on each end is required for all CDS drops with weights in excess of 7,000 pounds. A CGU-1B device may be used for weight up to 7,000 pounds.

j. Static lines -

(1). Attach parachute static line(s) to anchor cable(s).

NOTE

Ensure all G-12Ds are positioned with the bridle and 68-inch pilot parachute on the outboard or forward side of the container.

NOTE

Secure G-13/14 parachute static lines with retainer bands on parachute bag.

NOTE

All static lines for each container must be attached to the same anchor cable. Static lines with snap hooks require D rings for attachment to anchor cable.

(2). During over-the-ramp operation, containers followed by tailgating personnel, the breakaway static line will be used on all containers. The unused static line retriever will be rigged for retrieval of personnel static lines from the cargo ramp area.

APPENDIX B
C-141B TEST RIGGING PROCEDURES

C-141B TEST RIGGING PROCEDURES

THIS SECTION PROVIDES AIRCRAFT RIGGING PROCEDURES FOR THE CONTAINER DELIVERY SYSTEM (CDS) USING THE C-141B CENTERLINE VERTICAL RESTRAINT (CVR) AND ELECTROMAGNETIC GATE RELEASE DEVICE (GRD) SYSTEMS. CURRENT TO 1C-141B-9 RIGGING PROCEDURES WERE USED WHERE APPLICABLE.

1. The CVR system in conjunction with six electromagnetic GRDs permits the airdrop of a maximum 42 A-22 containers, 21 from each side of the aircraft. Depending on weight and cg limitations containers can be rigged for airdrop at six different drop zones, aerial delivering from 1 to 42 containers per pass. Operational requirements will dictate the rigging configuration.

2. Airdrop Platform Acceptance Check.

Check the following critical factors of the load:

- a. Applicable Air Force Technical Order.
- b. A-22 container(s) with skidboards 48-inch x 48-inch, 48-inch x 53.5-inch, and 48-inch x 96-inch are approved for airdrop.

NOTE

48-inch x 53.5-inch, and 48-inch x 96-inch plywood skidboards may be airdropped with the CVR installed by rotating the skidboard(s) 90 degrees to allow the 48-inch side to fit between the CVR and aircraft dual rails.

c. Weight of completely rigged load shall be within the limits specified in appropriate Field Manual (FM)/Technical Order (TO).

d. Check A-22 container(s) for skidboard condition and allowable dimensions.

CAUTION

Containers with damaged or warped skidboards may result in delayed release or a hung load.

CAUTION

Slack skidboard ties may contact rollers and prevent the container(s) from exiting the airplane.

3. Airdrop Loading Procedures.

CAUTION

Prior to loading airdrop item(s) on the aircraft, calculations must be made to determine where the item(s) must be positioned to ensure that the aircraft cg limits are not exceeded during or after individual airdrop sorties. (refer to TO 1C-141B-1, Section V for cg limits.)

WARNING

During container airdrop, the aircraft fuel and container load will be scheduled to ensure that the forward cg limits shall not fall forward of 25 percent Mean Aero Chord for any release of container(s) at the calculated air release point.

Load the airdrop item(s) on the aircraft and position at the desired location for flight. For CDS containers, prior to loading, prepare the aircraft as follows:

- a. Attach roller bridge assembly to the second roller from the aft end on each of the four aft-most main floor roller conveyor sections. This is accomplished by inserting the knurled knobs through the roller sleeve. No disassembly of the roller sleeve and its locking pins is necessary.
- b. Install anchor line cable stops at fuselage stations 1470 right and 1490 left. Ensure cable stops are securely fastened, and tape with any suitable aerial delivery tape.
- c. Install the buffer stop assembly (BSA) when the total A-22 containers weigh 5,001 pounds. When airdropping a combined rigged weight of 5,000 pounds or less, a chain gate system may be used in lieu of the BSA. Install the chain gate system as follows:

NOTE

The chain gate forward barrier system may be installed after the CVR is installed.

- (1) Install a 25,000-pound capacity combination fitting in the outboard left and right restraint rail sections at the fuselage station desired for the forward end of the container(s) to stop at. Route a 198-inch length of 1-inch tubular nylon around the overhead left and right outboard litter support bracket and attach to the 25,000-pound capacity combination fitting with a G-13 clevis. Attach a 10,000-pound capacity device to the top ring of each 25,000-pound capacity combination fitting. Route a 10,000-pound capacity chain across the cargo floor and connect to each device and tighten to remove visible slack. Route a 210-inch length of 1-inch tubular nylon around the over head left and right inboard litter support bracket and attach to the 10,000-pound chain with a G-13 clevis. The 198-inch and 210-inch lengths of 1-inch tubular nylon are locally manufactured with loops sewn on each end for the G-13 clevis.

NOTE

The chain gate system used as an alternate forward barrier is not to be considered as adequate forward restraint for takeoff or landing. Additional forward restraint must be applied IAW tiedown principles/procedures in Section IV of TO 1C-141B-9.

NOTE

Position the containers as tight as possible against the forward barrier.

Check general condition and security of all panels, braces and side rails, ensuring that no visible damage is detected.

WARNING

Any visible damage on any part of the buffer stop assembly which will reduce the structural integrity will be sufficient reason to reject the buffer stop assembly.

Load the buffer stop assembly either by K-loader or forklift with rollerized tines.

d. Ensure all detents are retracted aft of the load. Detents on ramp rail section will be secured with 1/4-inch cotton webbing.

NOTE

Extend the vertical restraint flanges if containers are loaded in this area and leave them extended throughout the drop.

c. Install the CVR system.

(1) Introduction: The Type II CVR system is designed for use in the C-141B aircraft. The CVR is secured to the aircraft floor using modified tiedown fittings. The rail is installed using D-row tiedown receptacles. The tiedown rings are located on the top of the rail and are rated at 10,000 pounds capacity.

(2) Description: Each system contains the following rail sections:

Section No.	Nomenclature	Section Length	Quantity	Weight
1	Aft ramp assembly	55"	1	25.0 lbs
2	Forward ramp assembly	60"	1	27.5 lbs
3	Aft cargo compartment assembly	46"	1	23.0 lbs
4	Interchangeable main assembly	80"	1	242.5 lbs
5	Interchangeable main assembly	40"	2	21.0 lbs

Each rail is 2.8 inches high and 13.8 inches wide. Total system weight is 627.5 pounds. When all sections are installed in the aircraft the CVR will extend from FS 332 to FS 1527.

(3) Tools and Personnel Required: A 3/8 inch open-end wrench is required to install/remove the CVR. Two people are required to remove or install the CVR.

(4) Installation Instructions:

CAUTION

If a CVR tiedown fitting can not be seated in a receptacle or is damaged, the CVR tiedown ring closest to the fitting **cannot** be used.

NOTE

The BSA must be positioned on the aircraft prior to installing the CVR.

NOTE

Prior to installing a CVR section ensure the tiedown fitting are in the unlocked position.

NOTE

If a CVR tiedown fitting cannot be secured in a receptacle, the nuts on the fitting may be loosened to allow the fitting to seat in the receptacle and then tighten.

- (a) Install section 1 on the aircraft ramp in fitting 5D and 4D.
- (b) Install section 2 on the ramp in tiedown receptacle 2D and 1D.
- (c) Install section 3 on the cargo floor in tiedown receptacle 56D and 55D.
- (d) Install number 4 sections as required.
- (e) If required, a number 5 section can be used when the distance between the buffer board and CVR section is 40 inches but less than 80 inches.
- (f) Removal of CVR is essentially the reverse of installation.

NOTE

When rigged weight of containers is 15,000 pounds or more, supplemental restraint will be applied directly to the BSA. Install chains from the BSA to available CVR and side rail 10/25K tiedown rings.

f. Install the GRD System:

(1) Description: The GRD is an electromagnetic device, which is attached to the CVR rail and is activated by 28-volt DC aircraft power routed through a control unit and a release activation button located at the primary loadmaster's position. The GRD was designed to be activated at the CARP. With the aircraft maintaining a positive deck angle, activation releases one end of a webbing gate, negating aft restraint, and allows the CDS bundles to exit the aircraft. The system contains these components:

- (a) A control unit consisting of: a switch to arm/dearm the system, a gate position select switch to isolate various gates, a system armed light, and 3 circuit breakers. Permanently attached to the control unit is a 60-foot main wire harness and an additional, removable 25

feet extension. The loadmaster's gate release button is attached to the control unit by a coiled 25-foot cord. The control unit is powered by a 25-foot electrical cord plugged into one of the two large aircraft 28-volt DC outlets (i.e. iron lung).

(b) Up to six GRDs, with electrical cable extensions to allow greater freedom in device attachment locations.

(2) Installation Instructions:

(a) Determine the number and rigging location of devices needed for the mission. One device and single ply of Type XXVI nylon webbing will provide all aft restraint requirements for up to 13,000 pounds of containers.

(b) Attach device(s) to CVR tiedown ring(s) with inspection opening facing outboard at preplanned gate locations.

(c) Route and tape with cloth reinforced rigging tape the main wire harness along the top of the CVR where it will not interfere with containers. Connect the 25-foot main wire harness extension if needed to reach aft gate positions.

(d) Connect release device electrical cable to main wire harness connector. Install an extension cable if required to reach main connector.

(e) Position control unit within 25 feet of one of the two large 28-volt DC outlets and plug in power cord to the outlet.

(3) Perform a system operational checkout.

CAUTION

Duty cycle for the release device is 5 seconds on and 20 seconds off.

(a) Pull and hold the cocking lanyard while swinging the spool free of the rocker arm. Release cocking lanyard. Slip the loop end of a Type XXVI nylon webbing gate over the spool of the release device, pull and hold the cocking lanyard and push the spool in past the rocker arm roller, then release the cocking lanyard to reset device so the rocker arm roller captures the spool/gate. Check for full extension of linear actuator tongue. Forward rocker arm roller must not rest on beveled slope of the tongue or full aft restraint will not be achieved.

(b) Place the arming switch on the control unit to the armed position and verify arming light is on.

(c) Set gate position select switch to position being used for drops.

(d) Apply a positive force against release device by pulling on webbing gate and while maintaining force, activate gate release button. Webbing should slip freely off the spool.

(e) Repeat steps (a) through (d) for each GRD being used.

(f) Dearm electrical power when checkout procedure is complete.

g. Load container(s) and position as tight as possible against the forward barrier.

4. After Loading Airdrop Containers (CDS):

a. Install Type XXVI nylon release gate(s) as follows:

- (1) Attach the loop end of Type XXVI webbing to the release device installed earlier.

CAUTION

Ensure the beveled portion of the linear actuator tongue is completely extended past the forward rocker arm roller. The release device will not provide full aft restraint if the rocker arm roller rests on any part of the beveled slope.

- (2) Attach a Van Zelm ratchet to the outboard right/left rail tiedown ring corresponding to location of release device. Thread the other end of the Type XXVI nylon through the container aft corner at or near vertical cg and above the horizontal band. The Type XXVI nylon should be under vertical bands at aft corners of container and on top of inner vertical bands. Thread end into Van Zelm ratchet. Tighten device until a minimum of one and one half turns of webbing is around the spindle to prevent slippage. Fold and secure excess webbing.

- (3) Ensure all electrical cables are positioned and secured away from containers and rigging materials.

b. Emergency Aft Restraint Requirements: CDS. An emergency aft restraint bridle constructed of Type XXVI nylon with a Van Zelm ratchet on each end is required for all CDS drops with weights in excess of 7,000 pounds. A CGU-1B device may be used for weight up to 7,000 pounds.

NOTE

Static Line Installation: CDS One non-break away static line is required for each container. Only standard cargo parachutes static lines shall be used. Hardware used with the static line shall allow for free skidding action on the anchor cable at all angles of application.

- c. Install static lines on anchor cables. Install the cotter key and bend both legs.

NOTE

Ensure all G-12Ds are positioned with the bridle and 68-inch pilot parachute on the outboard or forward side of the container.

- d. Install vertical restraint, utilizing CGU-1/B straps.

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APPENDIX C
C-130 CHECKLISTS

CDS RIGGING PROCEDURES (AMPLIFIED)

PRIOR TO LOADING

1. General Airplane Preparation For- COMPLETED

Ramp and Door Airdrop/Extraction

2. Seat Support Beams (as applicable) - REMOVED (if required)

a. Remove beam at FS 655 (left and right side) to provide access to wall tiedown rings.

3. Left and Right Detents - RETRACTED (as applicable)

4. Buffer Stop Assembly (BSA/ - INSTALLED Alternate Forward Barrier) (as applicable)

a. Load BSA and lock in position.

NOTE

See Section VII for installation requirements.

5. Detents Beside and Aft of Load- RETRACTED AND PINNED OUT

a. Left rail detents will remain retracted and right rail detents will be pinned out using pin provided in stowage hole.

6. Center Vertical Restraint (CVR) Rail - INSTALLED

a. Assemble and secure in position.

NOTE

See CVR, Annex C, IOT&E Final report, Jan 87 for installation requirements.

7. Electrical Control Cable - INSTALLED/SECURED

a. Route electrical cable from anticipated aft gate release device location, forward of BSA/Alternate Forward Barrier.

8. Control Unit - CONNECTED/INSTALLED

a. Connect Gate Release Device (GRD) electrical cable to main wire harness.

9. System Operational Check- COMPLETE

CAUTION

Duty cycle for the release device is 5 seconds on and 20 seconds off.

- a. Connect hook end of the gate release device to CVR tiedown ring.
 - b. Connect GRD to the electrical cable at its anticipated location.
 - c. Attach Type XXVI release gate loop to GRD spool and arm device.
 - d. Connect electrical cable from control unit to aircraft iron lung outlet.
 - e. Place Arm/Dearm switch to the "Armed" position. (Check release Armed Light On)
 - f. Place gate position select switch to desired position.
 - g. Apply positive force to the release gate against device.
 - h. Activate gate release button.
 - i. Accomplish steps a thru H for additional GRDs.
10. Load Acceptance Inspection - **ACCOMPLISHED**
11. Cargo Loading (Floor Load) Checklist - **COMPLETED**

**CDS RIGGING PROCEDURES (AMPLIFIED)
AFTER LOADING**

13. Container Rigging - COMPLETED

NOTE

See Section VII for instructions on rigging containers.

a. Install release gate(s)

- (1) Attach GRD(S) to CVR rail and connect electrical cable.
- (2) Attach Van Zelm ratchet(s) to outboard rail assembly.
- (3) Attach release gate loop to GRD spool and arm device.

CAUTION

Ensure the beveled portion of the linear actuator tongue is completely extended past the forward rocker arm roller. The release device will not provide full aft restraint if the rocker arm roller rests on any part of the beveled slope.

(4) Route loose end of release gate through container webbing and attach to Van Zelm ratchet.

b. Tie Van Zelm ratchet(s) with Type III nylon from the body, near the spool, to a tiedown/seat belt ring located aft of the ratchet(s) location after tension has been applied to the gate.

c. Attach static line(s) to anchor cable(s).

**14. Tiedown Restraint - INSTALLED AND
CHECKED**

a. Install vertical and additional forward restraint (as required).

15. Load Inspection - ACCOMPLISHED

**16. Airplane Preparation For CDS - COMPLETED
Airdrop**

LOADMASTER CDS CHECKLIST (AMPLIFIED)

TWENTY MINUTE CHECKLIST

(May be Accomplished Prior to Takeoff)

1. Twenty-Minute Warning - "ACKNOWLEDGED" (LM)
2. GRD Control Unit- **CHECKED**
 - a. Arm/Dearm Switch- **DEARMED**
 - b. GRD Select Switch.- **SET**
 - c. Control Unit Electrical Plug.- **CONNECTED**
 - d. Circuit Breakers - **CHECKED**
3. Forward Barrier- **CHECKED**
4. Gate Release Device(s) - **CHECKED**
 - a. Electrical Cable - **CONNECTED**
 - b. Release Gate - **ATTACHED**
5. Twenty-Minute Checks - "**COMPLETE**" (LM)

TEN MINUTE CHECKLIST

WARNING

Ensure that all personnel not involved with the airdrop remain seated forward of load with their seat belts fastened.

1. Ten-Minute Warning- "ACKNOWLEDGED" (LM)
2. Forward and Vertical Restraint- **REMOVED**
Strap(s) (as required)
3. Red Lights - **CHECKED**
4. Interphone and Radios- **SET**
5. Crew Forward of Load- **CHECKED**
6. Parachute/Harness and Helmet- **ON AND ADJUSTED**
7. Ten-Minute Checks - "**COMPLETE**" (LM)

FIVE MINUTE CHECKLIST

1. Five-Minute Warning - **"ACKNOWLEDGED"** (LM)
2. Ramp and Door - **"CLEAR TO OPEN"** (LM)
 - a. Check That the Aft Anchor Cable Supports are in the Up Position.
 - b. Check That the Ramp and Door Area is Clear.
 - c. Check That the Ramp and Door are Fully Open and Locked.
 - d. Check That the Cargo Door Uplock Flag is Visible (when possible).

NOTE

If the cargo ramp and door fail to open normally, the loadmaster may open them from the aft control panel upon clearance from the pilot.

WARNING

When the cargo ramp and door cannot be opened from the cockpit, the loadmaster will ensure his lifeline is attached and locked to a tie down ring no further aft than FS 677, or has a parachute properly fitted prior to proceeding aft to operate the cargo ramp and door controls.

3. Five-Minute Checks - **"COMPLETE"** (LM)

ONE MINUTE CHECKLIST

1. One-Minute Warning- **"ACKNOWLEDGED"** (LM)
2. Arm/Dearm Switch- **ARMED/LIGHT ON**
3. Data - **"READY"** (TM/LM)
(as required)
4. One-Minute Checks - **"COMPLETE"** (LM)

RELEASE POINT CHECKLIST

1. Cameras- **ON** (FTE/LM)
2. Gate Release Button - **ACTIVATED**
3. Status of Gate - **"GATE RELEASED"** (LM)
(or condition)
4. Arm/Dearm Switch - **DEARMED**

5. **"LOAD CLEAR" (LM)**
(or condition)

6. Post Drop Checklist

POST DROP CHECKLIST

1. **"CLEAR TO TURN" (LM)**

2. Cameras - **OFF (FTE/LM)**
(as required)

3. Data- **OFF (TM/LM)**
(as required)

4. Static Lines- **RETRIEVED**

5. Ramp and Door - **"CLEAR TO CLOSE;
CLOSED AND LOCKED" (LM)**

6. Post Drop Checks - **"COMPLETE" (LM)**

CLEANUP CHECKLIST

1. Forward Barrier Chains - **REMOVED**

2. Loose Equipment - **SECURED**

3. Emergency Restraint Strap(s) - **REPOSITIONED**
(if required)

4. Cargo Compartment - **SECURE**

CDS EMERGENCY PROCEDURES

GATE FAILS TO CUT/LOAD FAILS TO EXIT

1. Arm/Dearm Switch - **DEARMED**

2. Pilot Notified - **"MALFUNCTION" (LM)**
(or condition)

3. Ramp and Door - **"CLEAR TO CLOSE;
CLOSED AND LOCKED" (LM)**

CAUTION

If the load is jammed in the ramp area, notify the engineer to stop closing action when the cargo door is released from the uplock.

4. Load - **SECURE**
5. Post Drop Checklist

APPENDIX D
C-141B CHECKLISTS

**AIRCRAFT PREPARATION FOR CONTAINER DELIVERY SYSTEM (CDS) AIRDROP
USING THE GATE RELEASE DEVICE**

1. Forward Support Beam - **CHECKED**

2. Jump Signal Lights - **CHECKED**

Lights will be operated from the copilot position.

3. Anchor Cables - **INSTALLED/CHECKED**

Check for proper positions, attachment points, safe tied turnbuckles and for condition of cables.

4. Pressure Door Aux Latches, CAM Jacks, and Ramp Manual Safety Pins - **REMOVED AND STOWED**

5. Anchor Cable Hooks - **DISCONNECTED**

6. Pressure Door- **OPEN**

7. Aft Anchor Cable Supports - **CHECKED**

Ensure actuators have extended the aft supports. Check for proper anchor cable installation.

8. Static Line Stops- **INSTALLED**

Secure stops to anchor cables at FS 1470 right and FS 1490 left and tape.

9. Ramp and Petal Doors - **AS REQUIRED**

CAUTION

Prior to opening doors and ramp, coordinate for ground clearance.

10. Restraint Harness Attachment Rings - **INSTALLED**

Install attachment rings at FS 1313 right and left.

RESTRAINT RAIL AND ROLLER CONVEYORS

1. Restraint Rail End Bumpers - **AS REQUIRED**

When the number one rail sections are down, the end bumpers will be installed.

2. Restraint Rails- **CHECKED**

a. Ensure all rail sections are secured.

b. Ensure all detents are retracted. Detents on ramp rail sections will be secured with 1/4-inch cotton webbing (80-lb tape).

c. Check rail face for obstructions.

d. Ensure all vertical restraint lips are retracted/secure aft of containers or extended/secure adjacent to the container load. Leave extended through out the drop.

Roller Conveyors- UP AND LOCKED

Check all required roller conveyors for condition and ensure they are up, properly seated and locked.

NOTE

When inspecting the ramp roller conveyor channels (4), ensure the gap distance between guide assembly and channel assembly does not exceed 3/16 inch, in accordance with TO 1C-141B-2-1MS-1.

WARNING

Conveyors sections with damaged or missing rollers will be replaced for aerial delivery operations.

4. Roller Conveyor Bridges- INSTALLED

5. Buffer Stop Assembly(BSA)/ - INSTALLED/CHECKED
Forward Barrier

Check condition of assembly.

6. Centerline Vertical Restraint (CVR) System- INSTALLED/CHECKED

CAUTION

If a CVR tiedown fitting can not be seated in a receptacle or is damaged, the CVR tiedown ring closest to the fitting CAN NOT be used.

NOTE

The buffer stop assembly must be positioned on the aircraft prior to installing the CVR.

NOTE

Prior to installing a CVR section ensure the tiedown fittings are in the unlocked position.

NOTE

If a CVR tiedown fitting can not be secured in a receptacle, the nuts on the fitting may be loosened to allow the fitting to seat in the receptable and then tighten.

a. Install section 1 on the aircraft ramp in fitting 5D and 4D.

- b. Install section 2 on the ramp in tiedown receptacle 2D and 1D.
- c. Install section 3 on the cargo floor in tiedown receptacle 56D and 55D.
- d. Install number 4 sections as required.
- e. If required, a number 5 section can be used when the distance between the buffer board and CVR section is 40 inches but less than 80 inches.

7. Gate Release Device (GRD)(s) -INSTALLED

Attach the hook end of the release device to a CVR tiedown ring at the preplan gate location(s).

8. GRD Electrical Harness and Cables- INSTALLED

- a. Route main electrical harness from aft gate location along the top of the CVR to a position forward of the BSA/Forward Barrier. Add the 25 feet main harness extension if required.
- b. Connect GRD electrical cable to main electrical harness connector. Install a release device electrical cable extension if required.
- c. Tape down electrical cables to CVR if required to prevent their interference with the free movement of the container(s).

9. GRD Operational Check - POSITIONED/CONNECTED

Position control unit within 25 feet of an aircraft 28 Volt Iron Lung power receptacle. Connect control unit electrical cord to aircraft power receptacle.

10. Gate Release Device Operational Check - COMPLETE

CAUTION

The duty cycle for the release device is 5 seconds on and 20 seconds off.

- a. Pull and hold the cocking lanyard on the GRD while pulling out on the spool. Release the lanyard. Place the loop end of the Type XXVI nylon webbing gate over the spool, then push in on the spool until it clears the rocker arm roller. Now push in sharply on the rocker arm until it captures the spool. Check the linear actuator tongue to ensure it has fully extended. The bevel on the tongue must extend past the fwd rocker arm roller to provide positive restraint of the gate.
- b. Place arming switch to the armed position and verify arming light is on.
- c. Set gate position select switch to coincide with device being tested.
- d. Apply a positive force against release device by pulling on Type XXVI gate. With force applied, activate gate release button and ensure a complete release was accomplished.
- e. Accomplish steps a. thru d. for each additional release device used.

11. Dearm control unit.

AFTER LOADING AIRDROP EQUIPMENT (CDS) (AMPLIFIED)

1. CDS Release Gate(s)- INSTALLED

a. Attach a Van Zelm ratchet to an outboard rail ring which corresponds to gate release device installed previously in Aircraft Preparation For CDS Airdrop Checklist.

b. Attach Type XXVI release gate loop to release device, then feed through container and attach to Van Zelm ratchet and apply tension.

CAUTION

Ensure the beveled portion of the linear actuator tongue is completely extended past the forward rocker arm roller. The release device will not provide full aft restraint if the rocker arm roller rests on any part of the beveled slope.

c. Ensure release device electrical cable is positioned/secured away from containers and rigging.

d. Repeat steps a. thru c. for additional gates.

2. Tiedown Restraint- INSTALLED

Install vertical restraint and additional forward restraint, if required.

3. Static Lines - CONNECTED

4. Load Inspection- COMPLETED

Inspect the load using the Joint Airdrop Inspection Form.

5. Anchor Cable Hooks - CONNECTED

CAUTION

Ensure cable is in recess slot.

6. Roller Conveyors- DOWN/LOCKED

All roller conveyors not required for airdrop should be down and locked.

7. Emergency Aft Restraint Strap- CHECKED

Position straps for easy access.

8. Airdrop After Loading Check- COMPLETED

When all preceding items of the After Loading Airdrop Equipment (CDS) checklist have been completed proceed with the After Loading General checklist and accomplish the required items.

**C-141 LOADMASTER'S CDS AMPLIFIED CHECKLIST
(WITH GATE RELEASE DEVICE)**

TWENTY-MINUTE CHECKLIST

Twenty minutes prior to drop time, the navigator initiates the Twenty-Minute Checklist by stating "CREW TWENTY-MINUTE WARNING", the pilot then directs the crew to accomplish the CDS AIRDROP CHECKLIST.

1. "CREW TWENTY-MINUTE WARNING" (N) - "ACKNOWLEDGED" (LM,E)

2. GATE RELEASE CONTROL UNIT

- a. Arming Switch - **DEARMED**
- b. Gate Position Select Switch - **SET**
- c. Control Unit Electrical Plug - **CONNECTED**
- d. Circuit Breakers - **CHECKED**

3. BUFFER STOP ASSEMBLY/FORWARD BARRIER - **CHECKED**

4. RAIL LOCKS - **RETRACTED**

Ensure all locks are retracted beside and aft of containers.

5. VERTICAL LIPS (As Required) - **CHECKED**

Ensure all vertical restraint flanges are retracted aft of container locations. Extend flanges adjacent to containers and leave extended throughout the drop.

6. RELEASE GATE(S) - **CHECKED**

- a. Electrical Cable Connected To Release Device And Properly Routed
- b. Release Device Properly Attached To CVR Ring And Type XXVI Gate.

CAUTION

Ensure the beveled portion of the linear actuator tongue is completely extended past the fwd rocker arm roller. Full aft restraint is not provided if the roller contacts any part of beveled slope.

- c. Van Zelm racket strap properly attached to Type XXVI gate and rail ring.

7. DOOR AUXILIARY LOCKS, CAM JACKS AND MANUAL SAFETY PINS -
REMOVED AND STOWED

NOTE

Step 7 will not be accomplished until aircraft is depressurized.

8. ANCHOR CABLE RESTRAINT HOOKS - REMOVED

9. PRESSURE DOOR - "CLEARED TO OPEN" (P) "OPEN" (LM)

Open pressure door by aft control.

10. AFT ANCHOR CABLE SUPPORTS - EXTENDED/CHECKED

Supports must extend to airdrop position and anchor cables must be taut and dislodged from recesses in pressure bulkhead.

11. RAMP LOADING LIGHTS - POSITIONED

Lights will be pointed in a downward direction toward the extraction line restraint fitting.

12. OBSTRUCTIONS AFT OF THE LOAD REMOVED - COMPLETE

13. LOAD VERTICAL AND AFT RESTRAINT STRAPS - REMOVED

14. TWENTY-MINUTE CHECK - COMPLETED (LM,E)

TEN-MINUTE CHECKLIST

Ten minutes prior to drop time, the navigator initiates the Ten Minute Checklist by stating, "CREW TEN-MINUTE WARNING".

1. "CREW TEN-MINUTE WARNING" (N) - "ACKNOWLEDGED" (LM,E)

2. RED LIGHT - ON

3. SAFETY HARNESS/PARACHUTES/SEAT BELT - ON/FASTENED

Ensure that all personnel in the cargo compartment are in safety harness/ parachute/seat belts, as applicable (and flotation gear, if required).

Safety Harness will be worn on CDS airdrop missions when drop altitude is below 1000 feet AGL.

4. CONTAINER MARKER LIGHTS - ON (Night Drops Only)

5. TEN-MINUTE CHECK - "COMPLETED" (LM,E)

SLOWDOWN CHECKLIST

The copilot initiates this checklist after flaps have been extended during the slowdown maneuver by stating "SLOWDOWN CHECK".

1. "SLOWDOWN CHECK" (CP) - "ACKNOWLEDGED" (LM,E)
2. DOORS - "CLEAR" (LM)
LM will ensure the ramp and pressure and petal doors are clear.
3. DOORS - "OPEN" (LM)
4. SLOWDOWN CHECK - "COMPLETED" (LM,E)

ONE-MINUTE CHECKLIST

One minute prior to drop time, the navigator initiates the one-minute checklist by stating, "CREW ONE-MINUTE WARNING".

1. "CREW ONE-MINUTE WARNING" (N) - "ACKNOWLEDGED" (LM,E)
2. DATA - READY (TM,LM)
 - a. Checked That Camera(s) Are Plugged In And Set To Operate.
 - b. Check That Recording Devices Are Properly Attached And Set To Operate.

CARP CHECKLIST

The navigator initiates this checklist by stating, "FIVE, FOUR, THREE, TWO, ONE, GREEN LIGHT".

1. DATA - ON

At navigator count of five turn on camera(s) and recorder(s).

2. GATE RELEASE ARMING SWITCH - ARMED/LIGHT ON

At navigator count of five, place gate release arming switch to the armed position.

3. GATE RELEASE PUSH BUTTON - ACTIVATED

As the navigator announces "GREEN LIGHT", the loadmaster pushes and holds the gate release button until the release device(s) actuated.

CAUTION

The duty cycle for the release device is 5 seconds on and 20 seconds off.

4. STATUS OF LOAD - **"ALL CLEAR" OR "MALFUNCTION" (LM)**

5. RED LIGHT - ON

POST DROP CHECKLIST

After completion of the airdrop (Red Light), the copilot initiates the post drop check by stating "POST DROP CHECK".

1. GATE RELEASE ARMING SWITCH - **DEARMED**

2. DATA - **OFF**

3. STATIC LINE(S) - **RETRIEVED**

4. DOORS - **"CLEAR" (LM)**

5. PETAL DOORS AND RAMP - **"CLOSED" (LM)**

If aircraft is to be pressurized, stow anchor cables, close pressure door, and install pressure door auxiliary locks, cam jacks, and install the cargo ramp over center lock pins. Advise the pilot upon completion.

6. LOADMASTER'S POST DROP CHECK - **"COMPLETED" (LM)**

Disconnect static lines. Secure all loose items and check general condition of the cargo compartment.

CDS MALFUNCTION CHECKLIST (Using Gate Release Devices)

GATE DOES NOT RELEASE OR LOAD FAILS TO LEAVE AIRCRAFT

This checklist will be initiated if the loadmaster announces "MALFUNCTION" during a CDS drop.

1. PILOT NOTIFIED - **"MALFUNCTION" (LM)** State the nature of the malfunction.

2. GATE RELEASE ARMING SWITCH - **DEARMED**

WARNING

Loadmaster will not proceed aft of load until cleared by the pilot.

3. LOADMASTER CLEARANCE - **"CLEARED AFT TO SECURE LOAD" (P)**

4. LOAD - **SECURE**

Loadmasters will move toward the rear of the load (one LM on each side) and install

emergency aft restraint and advise the pilot that the load is secure. Loadmasters will avoid getting directly behind the load if at all possible.

5. MALFUNCTION CHECKLIST- "COMPLETED" (LM,E)

LIST OF ABBREVIATIONS AND SYMBOLS

<u>Abbreviation</u>	<u>Definition</u>
AFFTC	Air Force Flight Test Center
AFTS	Airlift And Trainer Systems
AGL	above ground level
ASD	Aeronautical Systems Division
BSA	bulk stop assembly
CARP	computed air release point
CDS	container delivery system
cg	center of gravity
CVR	center vertical restraint
DAC	Douglas Aircraft Company
DC	direct current
DD	Department of Defense
deg	degrees
DTIC	Defense Technical Information Center
DT&E	Developmental Test and Evaluation
FS	fuselage station
fwd	forward
G	normal acceleration due to gravity
GRD	Gate Release Device
IAW	in accordance with
KIAS	knots indicated airspeed
L	left
lb	pound
MAC	Military Airlift Command
MACR	Military Airlift Command Regulation
NA	not available
No.	number
NTIS	National Technical Information Service
PN	part number
%	percent
R	right
sec	second
S/N	serial number
TAC	Tactical Air Command
T.O.	technical order
TR	technical report